Federal Ministry
of the Interior

# KBSt* Letter No. 2/2000

# Open-Source Software in the Federal Administration

**February 2000**

# KBSt

# KBSt Letter No. 2/2000

# Open-Source Software in the Federal Administration

*KBSt Letters are publications by the Co-ordination and Advisory Agency of the Federal Government for Information Technology in the Federal administration at the Federal Ministry of the Interior. In accordance with No. 17 para 2 Nos. 8 and 11 of the Regulations for the use of Information Technology in the Federal Administration (IT Regulations) dated 18 August 1988 (Interdepartmental Circular [GMBl]. p. 470) they serve to provide an overview of developments and experience in the IT area for the IT planning of the Federal authorities.*
*Information, comments, suggestions, proposals for topics and contributions to KBSt Letters can be addressed to the KBSt.* ***The KBSt is very interested in experience with Open-Source Software. If you have such experience, please inform the KBSt.***

Federal Ministry of the Interior
Section O 6 - KBSt
Postfach 17 02 90

53108 Bonn

Authors: Rudolf E. Bahr (BSI[*]), Ralf Reiländer, Egon Troles

e-mail            linux@kbst.bund400.de
Internet WWW      http://www.kbst.bund.de

---

[*] Federal Office for Security in Information Technology

# *Open-Source Software in the Federal administration*

## *Summary*

*In offices in the public administration, large numbers of workplace PCs are used as clients, and higher-performance PCs as servers. Many authorities are at present in the process of replacing old systems. In industry, Open-Source Software (OSS) is currently gaining increasing significance through the Linux operating system. Linux as an operating system, in connection with other OSS, has already been in use on servers in authorities for quite some time, and has shown itself to be an extremely reliable solution in this area (aspect of availability).*

*When processing confidential matters, the focus is on confidentiality. Here, OSS operating systems offer possibilities by virtue of their special configurability, a subject on which the Federal Office for Security in Information Technology (BSI) has already initiated projects to develop a secure PC with a secure network connection.*

*In the office environment, with its special requirements in terms of user friendliness, Open-Source Software has so far only been deployed sparingly. With the development of graphical user interfaces, which are not part of actual OSS operating systems such as Linux or FreeBSD, the open-source side has now closed the gap compared with commercial products. In terms of application software using graphical interfaces, there are now several OSS office packages. Amongst others, SUN's StarOffice package is available for commercial use and is free of charge.*

*Additionally, providers of commercial office software such as Corel, Oracle, Informix or SAP have ported their products to OSS operating systems, so that there is now a wide selection available.*

*It is already possible to satisfy office requirements entirely using Open-Source Software. A successful migration strategy must be orientated towards coexistence between the software of a variety of manufacturers, taking account of the existing equipment level.*

# Situation in the authorities area

The situation in the offices of the Federal administration is characterised by the deployment of office communication packages from a single manufacturer. In addition, Information Technology faces considerable challenges and high expectations from the political arena, whilst at the same time one cannot expect the available budget to increase tangibly. Against this background, many people responsible for IT are wary of changing to another IT environment. In many cases, the reasons given include exaggeratedly high migration costs, in particular an excessive training requirement. The current situation is exacerbated even further by the fact that in most cases new hardware is needed in order to use the latest versions of the software packages since the existing hardware does not achieve the performance required by the new software.

The disadvantages resulting from this dependency are many and varied. The products are often expensive and there are frequent upgrades or releases. In most cases, documents must be saved in a proprietary format; documents from newer versions cannot be satisfactorily processed by older versions of the program. The use of proprietary interfaces makes it difficult or impossible to use competing software. Users cannot be sure that the range of products with which they have become familiar will continue to be available in future.

In the past, many events have cast doubt on the reliability of commercial operating systems and hardware, particularly in terms of confidentiality. One shortcoming of such operating systems, as well as of commercial office packages, is that the program code cannot be read. During the 57th Conference of the Data Protection Commissioners of the Federation and the Länder, the Commissioners therefore wrote a resolution on the topic "Transparent Hardware and Software"[3].

They recommend users of modern technology to "only use products which are transparent in terms of the way they operate".

Very recently, the EU Commission has also criticised the lack of accessibility of the source code in commercial products, discussed giving precedence in calls for tender to open-source competing products, and recommended the promotion of Open-Source Software [4].

# How Open-Source Software came about, definitions

Linux is an operating system suitable for a large number of hardware platforms. It was developed in 1991 by Linus Torvalds, whose work has been built upon since then by a large number of developers all over the world. At that point in time, "Berkeley Software Distribution" (BSD) from UNIX was not yet freely available. Then BSD was made open source, and other similar OSS operating systems have been derived from it, each having specific points of emphasis: NetBSD [5], which runs on a wide variety of hardware platforms, OpenBSD [6] which is aimed at security and FreeBSD [7].

This was made possible because from the outset Linux (and later also BSD) was placed under the General Public License (GPL [49]). This licence guarantees anyone free access to the source code of the Linux operating system. Linux can be distributed, used and expanded freely and free of charge. Developers can therefore see all the source code, can very simply integrate new functions and can find and eliminate programming errors. Drivers for new adapters (SCSI controllers, graphic cards, etc.) can be quickly integrated. Linux itself is now being used by almost 16 million users [35].

To be exact, Linux is only the core of the operating system; the non-core programs are parts of a so-called distribution, of which there are now a very large number [8]. For instance, hardware recognition on start, ease of installation and configurability or stability depend on the distributions, which in some cases show considerable differences, down to the operating system cores [9]. There are also special distributions fitting on one or two diskettes, which need no hard disk and can be temporarily loaded onto a computer, for instance in order to analyse a network, without disturbing the operating system already installed there. As a rule, users are not aware of much difference in the distribution.

FreeBSD is a complete OSS operating system. There is only one distribution. The development aims are that it should be easy to install and that the production environment should be stable. For licensing reasons, it was not made open source until a later date, and is still relatively unknown. There is therefore virtually no ported commercial software, but most commercial software which has been ported to Linux (including driver software) is binary compatible with FreeBSD. What is remarkable is an excellent manual covering almost 800 pages [7a].

Features shared by Linux and FreeBSD are that both are multi-user operating systems. Apart from use on servers, this feature is also advantageous for office computers, which usually only have one user. The latter can register on his/her system several times with the same or different User IDs with different rights, and hence has several ASCII virtual terminals available in addition to his/her graphical interface for various applications.

Several graphical interfaces are now available as Open-Source Software for Linux and FreeBSD (XFree86 [10], KDE [11], GNOME [12]). Office requirements can hence be graphically implemented on the Linux or FreeBSD operating systems. These interfaces provide four or more virtual displays in which overlapping windows can still be shown, but where the usual window confusion is considerably reduced.

# Commercialisation of OSS

It is possible at present to observe a commercialisation of Linux which provides benefits for customers. It is still the case that software provided with the distributions can in most cases be

copied at will. As a rule, the complete distribution can be copied immediately with no problems (e.g. Debian or SuSE). This means that, for instance, it would be sufficient for the Federal administration to acquire one distribution.

At the beginning of 2000, IBM decided "to embrace the open-source operating system Linux on all of its server hardware product lines … The latest Linux activities show that IBM regard Linux as a strategic operating system platform. Linux support for IBM Network Stations now offers thin client users a highly configurable, individually adaptable system - on both the client and the server side. The advantages of thin client solutions lie in quick, flexible application installation, and in the low overall costs." [43]

The share of the Linux operating system on the server market increased from 16 percent in 1998 to 25 percent in 1999 [44]. This means that Linux has pushed Novell's Netware system from second place [45]. Linux is now also being deployed on IT equipment which is used only for Internet access [46].

It can also be observed that more and more providers of commercial software are porting their products to Linux. In the area of business applications the ISIS software database has now registered 931 products [47]. This includes companies like SAP [48], Oracle, Informix, IBM, ABAS, Corel, Sybase and Infopark.

# Office requirements

In the office area, operating systems with a graphical user interface (Windows, Mac) and office packages which are common on the market (MS Office, Corel WordPerfect, Lotus, StarOffice, VMS Office, etc.) have set the standards. As a rule, office users would expect to find the graphical interface and all types of applications immediately available as clickable icons once they have started their computers. As a rule, word and table processing, business graphics, scheduling, perhaps a database application, e-mail and an Internet connection are required.

As office software one can consider the commercial products StarOffice [14], which is now free of charge for use in authorities, and Corel WordPerfect 8 [15]. Filter functions for data exchange have solved the fundamental problem posed by proprietary file formats. By now, the PDF format is recommended by virtue of a resolution passed by the Interdepartmental Co-ordination Committee for Information Technology (IMKA) [36], the Procurement Agency provides information on reductions available in acquiring the necessary software from Adobe. It should also be stated with regard to Corel WordPerfect that this product now contains interfaces to PDF. The "filter functions" of StarOffice have been tested at the Federal Office for Security in Information Technology and deemed to be useable in practice. The Applixware office system is regarded as a "very lean" system. Open-source office packages worth mentioning are Siag Office [16] and KOffice [17]. The latter is already at a highly advanced stage, but still needs further development in respect of the filter functions for the proprietary file formats of several commercial manufacturers. Further office software is listed at [18].

Corel recently presented its Linux distribution developed on the basis of Debian [15] which also contains a Linux core which is common to all distributions, and particularly stresses ease of installation. This distribution is also to be free of charge, but can be obtained in connection with the WordPerfect version ported to Linux, for which a fee is still charged.

The Procurement Agency of the Federal Ministry of the Interior has concluded framework agreements [19] with a number of software manufacturers. Federal authorities can call on these framework agreements, as can other agencies within the public administration where opening clauses exist.

# Possible uses in the office area

Realistic solutions for a migration to OSS in the office area can only presume coexistence of the current and the new software, usually sourced from a variety of manufacturers. Some possible solutions are merely outlined below. Assistance in working out a specific solution can be provided by more than 100 companies [29 & 30].

Each authority should pay attention to "Linux or FreeBSD compatibility" when purchasing hardware and make this a requirement in calls for tender and contracts. This no longer plays a major role in most of today's PCs, but might be important when purchasing laptops or notebooks. Since these frequently use special components for which there are as yet no drivers, this might lead to problems in the short term. See [47] for driver programs, and [20] for hardware supported.

## 1. File and print servers

Windows NT file and print servers can be completely replaced by a Linux (or FreeBSD) and Samba solution [37]. Samba [21] is Open-Source Software and can deal with the SMB/CIFS protocol used in some commercial products, as well as the NFS protocol common in UNIX environments. One is therefore offered a reasonably-priced, stable solution for these server services which can be used by Linux, FreeBSD and Windows computers (clients). [22]

## 2. Equipment on classical PCs

As with the approach pursued to date, workplace PCs are usually made operational for users by a support group within the authority and connected to the internal network. Linux or FreeBSD are installed as an OSS operating system, a graphical OSS interface and the necessary office packages are installed in OSS or commercial versions. The hardware costs may fall since Open-Source Software uses resources very sparingly, and therefore hardware can usually be used for longer. The software costs fall to the degree that OSS is used. However, it should be noted that when graphical user interfaces are used, and also with Linux, certain hardware requirements should be met since otherwise it is not possible to work at a high speed. The appliances recommended in KBSt Letters from 4/1997 [38] onwards are however sufficient. One can work very well with the appliances proposed in the KBSt Letter 4/1999 [39]. They can even be used as servers. Older equipment still can be used as network servers because of the resource-saving characteristics since the server does not necessarily need a graphical interface. There are broad areas for use, in particular with slower external interfaces (e.g. ISDN selection connections for fax and e-mail). Here, the characteristic of Linux or FreeBSD that the systems provide excellent support for older hardware proves to be an advantage.

## 3. Program servers and network computers

An interesting alternative to office PCs, each of which is equipped with all the programs needed by the users ("Fat PC") is provided by client-server solutions using network computers as clients [23]. Not dissimilar to earlier mainframe computers + X terminal operation, all application programs are kept on application servers, where they are also run. The user data are also kept there. Only entry and output take place within a graphical interface on the office computers, which in their "extreme form" no longer need hard disks, CD-ROM or diskette drives ("Thin PC"). It is naturally also possible to implement "mixed forms" with which only a few applications are stored on the server. "Workplaces which primarily use typical office applications are best suited to this solution" [24]. More on "clients" at [25]. The advantages are:

- Greater availability of the office computers because totally without moving parts ("extreme form").

- Administration / upgrade takes place almost exclusively on the server.
- No data backup or virus infections on the office computers.
- Lower costs and less risk of theft for hardware with no hard disks or drives.
- Older PCs can also be used to good effect.
- No additional software; all machines can therefore be remotely administrated.

The disadvantages are:
- There are only vague requirements for server capacity expansions; in the end only a test helps [26].
- High dependence on servers, with all users being affected by a fault.
- Possible user acceptance problems (see [26] on how to overcome these).

Göttingen Student Union has implemented a PC network on this basis. They state on the framework conditions: *"Especially in respect of the well-known limited financial resources available to public facilities, Linux is a more than useable alternative [to] continued use of the existing hardware without restricting operation comfort and speed [in order] later to create and operate decentralised, Internet-capable workplaces with a minimum of administrative effort."*

Web browsers, mail programs, chat clients, office packages and user data are held on Linux terminal servers and launched by the clients. [27] lists a few experiences concerning server requirements: dual processor PC (Intel P II 350 MHz, 1024 MB internal memory) for up to 40 clients. According to [27], the clients have negligible hardware requirements: 486DX66 processor, 16 MB internal memory, 2 MB graphic card, 17" monitor, no hard disk, no CD-ROM or diskette drive. It was possible to continue to use the existing hardware. Even if new hardware were to be purchased, less than DM 1,000 per workplace would suffice.

## Integrating proprietary software

Integrating Open-Source Software and commercial software is always difficult where proprietary interfaces are used.

There is however a solution. It is already possible to set up on a PC both Windows and a Linux- or FreeBSD operating system. One of the two must be selected when starting the computer. It is even possible to access the data of the Windows side from the Linux or FreeBSD side and read and write, but not vice versa. An interesting commercial product was presented recently going by the name of "VMware".

VMware [28] provides on a PC several operating systems irrespective of the hardware, via a virtual standard machine:

On a classical PC (P II 266 MHz, 128 MB internal memory) a Linux-based operating system is installed and VMware set up on it. VMware can also be directly installed on the hardware.

It is now possible to install several different operating systems (Linux, FreeBSD, MS-DOS, Windows 3.1, 95, 98, NT, but not OS/2), and each guest system has its own window on the graphical interface after Start. System programs and applications are held in a system-specific directory in a file the size of which can be pre-set. No separate partitions are therefore needed.

The user can allocate the CD-ROM and diskette drives, of which a PC normally only has one each, to the virtual computer which he/she needs at any particular time (or to the basic system) using a pull-down menu. The virtual computer needs its own IP address if it is to have access to the internal network.

Applications can now be run on any virtual computer or on the basic system if this has been installed, and can have access to the data of the other systems via "Samba" [21].

In tests carried out at the Federal Office for Security in Information Technology, it emerged that installation was problem-free and the characteristics of the program were highly promising. VMware could provide a solution in all areas where it is impossible to avoid using and integrating proprietary software products.

According to the manufacturers, VMware is currently largely a desktop system. It is however intended to release a server version with an appropriate licence model.

The open-source project FreeMWare [28], which has similar goals to VMware, is in the development stage. It is possible to use Linux, or other UNIX-similar operating systems can be added into which Windows systems can be incorporated. Hence, software manufacturers who are planning to port their products to UNIX, but have not yet done so, are able to make an interim step. The software is already being made open source.

# Support

There are now enough innovative, quickly-growing companies offering system planning and support in using Open-Source Software, including in connection with proprietary software. Increasingly, this service is in fact offered seven days per week, 24 hours a day. The companies work with developers via the Internet.

See [31] for an example of support databases accessible online which cover the entire range of possible problems.

The Federal Office for Security in Information Technology has released a tool called USEIT [32] for secure Linux and UNIX administration. It helps recognise and deal with security loopholes in Linux and UNIX operating systems, and examines stand-alone computers and systems in networks. It has been developed for a whole series of UNIX systems.

There is a Linux distribution [33] by the name of "Trinux" which is specifically suited to the administration of networks. Trinux is temporarily loaded into the internal memory on a computer running the Linux or FreeBSD operating system to diagnose a network without disturbing the existing installation. It contains a large number of programs from the Unix toolkit, monitoring utilities, port scanners, packet sniffers and programs to test network services [34].

# Installation effort for Linux

PC systems are typically installed ready to use at users' workplaces. There is generally no provision for user installation. Hence, the argument that "Linux is difficult to install in comparison to other operating systems" is no longer valid.

The magazine Chip provided a Caldera Linux CD and a StarOffice CD in its 02/2000 issue [40]. The magazine largely concentrates on home users. According to tests carried out on this CD, it can be installed without problems, using a graphical user interface. This is available immediately the CD has been booted. There are no inconvenient reboots at any time during the installation procedure. Similarly problem-free installation via graphical user interfaces is now also available with other distributions (e.g. SuSE). A few experience reports comparing Linux with Windows NT are available on the Internet [37].

It is even more interesting if one regards installation in a professional environment. This is where the Linux OSS operating system demonstrates its great flexibility. It can be installed from CD-ROM, via a network, FTP, etc. Otherwise, it is possible to run it fully automatically without purchasing additional software and using BOOT-PROM's installations on a client workplace PC. It is also

possible to distribute the software using the tools belonging to Linux. This makes Linux particularly interesting for Federal authorities since they are frequently dislocated (e.g. through the move of the seat of Government to Berlin) and for cost reasons have concentrated their system administration in one location.

# Cost point of view, economic viability

Because of the fact, that there are no licence fees for OSS, there are possible savings for the authorities using other software than OSS. **The KBSt will be providing more detailed information on the potential savings in another Letter.** In order to document these possibilities in greater detail, it is also planned that a list of criteria will be created for the IT economic feasibility study [42] for comparison with OSS.

Possible savings emerge in particular for authorities which are in the process of changing their IT environment, for example in migrating from a Windows 3.x-based environment to Windows 95/98 or to NT. For authorities presently completing a version change, it is also worth listing the costs. The new versions frequently provide so many new possibilities that training is unavoidable.

# Longer hardware use

According to [39], a workplace PC costs about DM 3,000 to 4,000. The hardware can be used for longer because the operating systems use its resources sparingly. This means that OSS operating systems offer a further cost advantage.

# Training needed, training offered

The time when it was only possible to get OSS software running by spending a long time studying online manuals and there was virtually no training available are now long past. Many companies in the support area offer training. Additionally, there are also a large number of OSS seminars on offer from the classical providers of further training, and here in particular on Linux. In this context, one might study the current offering from the Federal Academy for Public Administration. The seminars offered there, I 4.21 (Basic Unix), I 4.30 (TCP/IP network administration) and I 4.35 (Administration of Web servers) have been running for two years on systems equipped with Linux.

# Is Open-Source Software secure?

Making the software open source alone does not mean per se that it is secure. As a rule, users, as well as programmers, will be totally unable to ascertain whether a specific program is secure. Only a small group of specialised experts will be able to do so, and that only after a detailed study. Everyone else must therefore rely on second-hand information.

In spite of the questions which remain open, the fundamental precondition for evaluating the security of software is certainly for its source code to be made open.

Open-Source Software meets this precondition. Added to this is the fact that the manufacturers are always known by name and can be reached. Solutions are offered in the specialist press and on the Internet should problems arise [1 & 2].

In the project operated by the Federal Office for Security in Information Technology to secure, control and manage networks, it has been shown that more recent approaches with distributed applications (agent systems, etc.) make access to the source text of the operating system absolutely necessary.

The availability of Linux (or FreeBSD) and open-source application programs in daily operation has been proven. With the Linux operating system stability has been achieved through strict separation of the production core (2.2.x) and the development core (2.3.y). A development core is not transferred into a production core until thorough tests have been carried out. FreeBSD is also separated between stable and as yet unstable release versions.

## Conclusion

In the foreseeable future, a successful strategy aimed at escaping dependence on one particular manufacturer can only consist in the coexistence of products using Linux, FreeBSD and other Open-Source Software with other commercial products. This might even mean added effort at the outset in view of parallel support for users within the authority. The use of the term "investment protection" cannot mean however that one should remain with the product range of one manufacturer for forever and a day.

Questions as to liability with Open-Source Software still need to be clarified, especially in comparison with practice in product liability to date.

With Linux or FreeBSD as an operating system, and with both supplementary Open-Source Software and commercial software on OSS operating systems, a stable, reasonably-priced, resource-saving, secure computer system is available, including for the professional office environment, supported by a sufficient number of consultancy firms. This applies both to the client and server area. In particular through the broad echo in the environment of the IT industry, Linux today offers good investment protection.

# Sources

[1]     Linux Magazine, monthly, article "INSECURITY NEWS" http://www.linux-magazin.de/ausgabe/1999/02/Insecurity/insecurity.html

[2]     http://lists.nas.nasa.gov/archives/ext/linux-security-audit/

[3]     57th Conference of the Data Protection Commissioners of the Federation and the Länder, Schwerin, 25/26 March 1999, Resolution: Transparent Hardware and Software

[4]     "TRUST AND SECURITY IN ELECTRONIC COMMUNICATIONS: THE EUROPEAN APPROACH", Erkki Liikanen Commissioner for Enterprise and Information Society European Commission, Information Security Solutions Europe (ISSE 99) Welcome Address, Berlin, 4 October 1999

[5]     http://www.netbsd.org

[6]     http://www.openbsd.org

[7]     http://www.freebsd.org

[7a]    Greg Lehey: "The Complete FreeBSD", Walnut Creek CDROM Books, ISBN 1-57176-246-9 almost 800 pages, FreeBSD on 4 CDs

[8]     http://www.linuxlinks.com

[9]     Periodical UNIX 7+8/99, p. 24: Linux-Distributionen im Vergleich, Linux * 3 = ?

[10]    http://www.xfree86.org

[11]    http://www.kde.de

[12]    http://www.gnome.org

[13]    http://www.applix.com/applixware

[14]    http://www.stardivision.de

[15]    http://linux.corel.com

[16]    http://siag.nu and IDC

[17]    http://koffice.kde.org

[18]    http://www.linuxapps.com, see at "Office / Business"

[19]    Procurement Agency of the Federal Ministry of the Interior, Section IX, http://www.BeschA.bund.de

[20]    http://www.linuxdoc.org/links.html#hardware, http://www.freebsd.org/handbook/hw.html}

[21]    http://www.samba.org

[22]    Linux Magazine 08/98, Linux als Allroundserver im Windowsnetz, http://www.linux-magazin.de/ausgabe/1998/08/Windowsnetwork/windowsnetwork.html

[23]    Computerwoche Magazine 27/99, p. 59: "Nach drei Jahren stellt sich bei Ncs die Frage: Top oder Flop?"

[24]    Computerwoche Magazine 27/99, p. 54: "Thin Clients halten nur langsam Einzug in die Unternehmen"

[25]    http://www.thinner.de

[26]    Computerwoche Magazine 27/99, p. 56: "Windows-based Terminals - gut geplant ist halb gewonnen"

[27]    Linux-Magazine 08/99, p. 38: "Diskless X-Terminals unter Linux: Gut gebootet"

[28]    Information, Download and 30 day licence: http://www.vmware.com

[28a]   http://www.freemware.org, http://www.bochs.com

[29]    UNIX OPEN Magazine, December/January 1999: 111 Systemhäuser mit Linux-Erfahrung

[30]    Web site of Innominate, Berlin: http://www.linuxbiz.de

[31]    Web site of SuSE, Nuremberg: http://www.suse.de/sdb/de/html/}

[32]    http://www.bsi.de/aufgaben/projects/useitool/useit.htm

[33]    http://www.trinux.org

[34]    c't Magazine 1999, Heft 4, p. 87: "Netzwerkdiagnose per Floppy", http://www.heise.de/ct/99/04/087/

[35]    Information from http://www.linux.de

[36]    IMKA resolution on the use of the PDF format dated 27.5.1999 (O 1 KBSt - 195 052 - 1/17 dated 7.7.1999)

[37]    http://thetoolhouse.com/qcoldiro/LinuxPresentation.html

[38]    KBSt Letter No. 4/97 Guideline prices for personal computers and workplace printers and information on purchasing personal computers for the drafting of the 1999 framework IT concepts (http://www.kbst.bund.de)

[39]    KBSt Letter No. 4/99 Guideline prices for personal computers and workplace printers and information on purchasing personal computers for the drafting of the 2001 framework IT concepts (http://www.kbst.bund.de)

[40]    Chip Magazine 2/2000 p. 20: Linux-Workshop: Problemlos umsteigen und Caldera Open Linux neben Windows installieren (http://www.chip.de)

[41]    http://martin.schmitt.net/linux.html

[42]    http://www.rothig.de, Internetpage on IT economic feasibility study, http://www.kbst.bund.de/papers/sr/ Schriftenreihe der KBSt, Band 26

[43]    http://www.de.ibm.com/pressroom/presseinfos/2000/20000216-2.html, IBM Deutschland press release dated 9.2.2000

[44]    Study by the IDC (International Data Corporation) market research enterprise

[45]    Linux has thus pushed Novell's Netware system from second place. (iBusiness dated 11.2.2000)

[46]    World premiere: Linux set top box as the alternative to the d-box with new features at CeBIT 2000, http://de.news.yahoo.com/000215/36/k8f7.html

[47]    Computer Zeitung No. 1+2 dated 13.1.2000, p. 14

[48]    http://www.sap.com/germany/pdf/sap_linux.pdf and http://www.sap.com/germany/press/sapinfo/magazin/mag_9911/pdf/s71.pdf

[49]     GNU General Public License at http://www.gnu.org/copyleft/gpl.html